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(54) Abstract Title
An articulated lift truck

(57) A lift truck (10) including a pair of rear wheels (16) mounted on a body (12), and a pair of front wheels (36) rotatably mounted on opposing ends of an axle (40), such that the axes of rotation (42) of the front wheels are fixed relative to each other, the axle being capable of rolling relative to the body. The truck is steered by the articulation of the front wheels about a pivot (32) through substantially 90 degrees either side of a straight ahead position relative to the body of the truck. All four wheels of the truck can be driven.

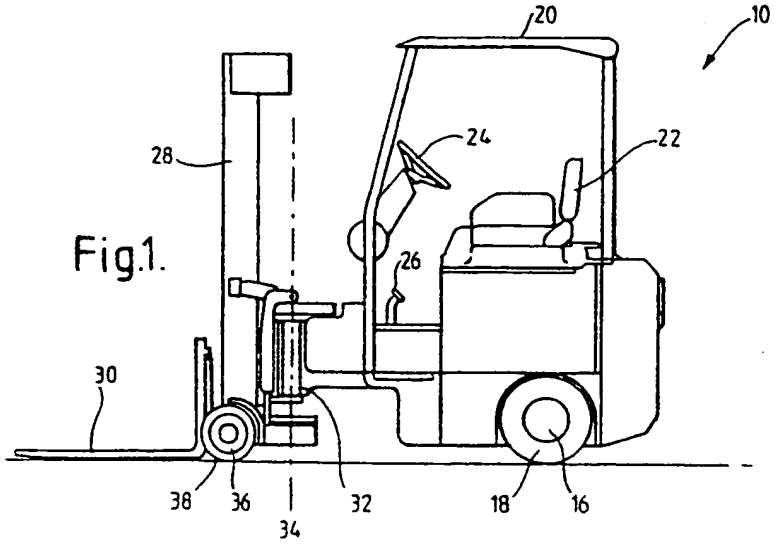

Fig.1.

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

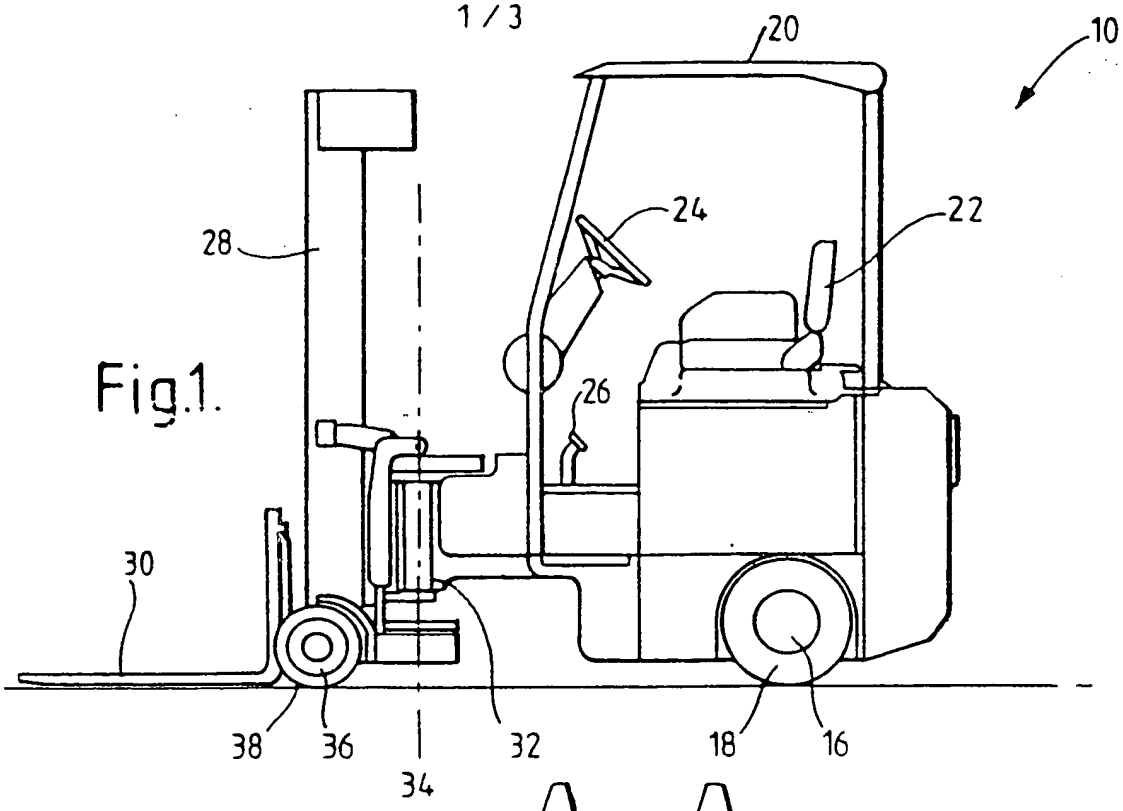
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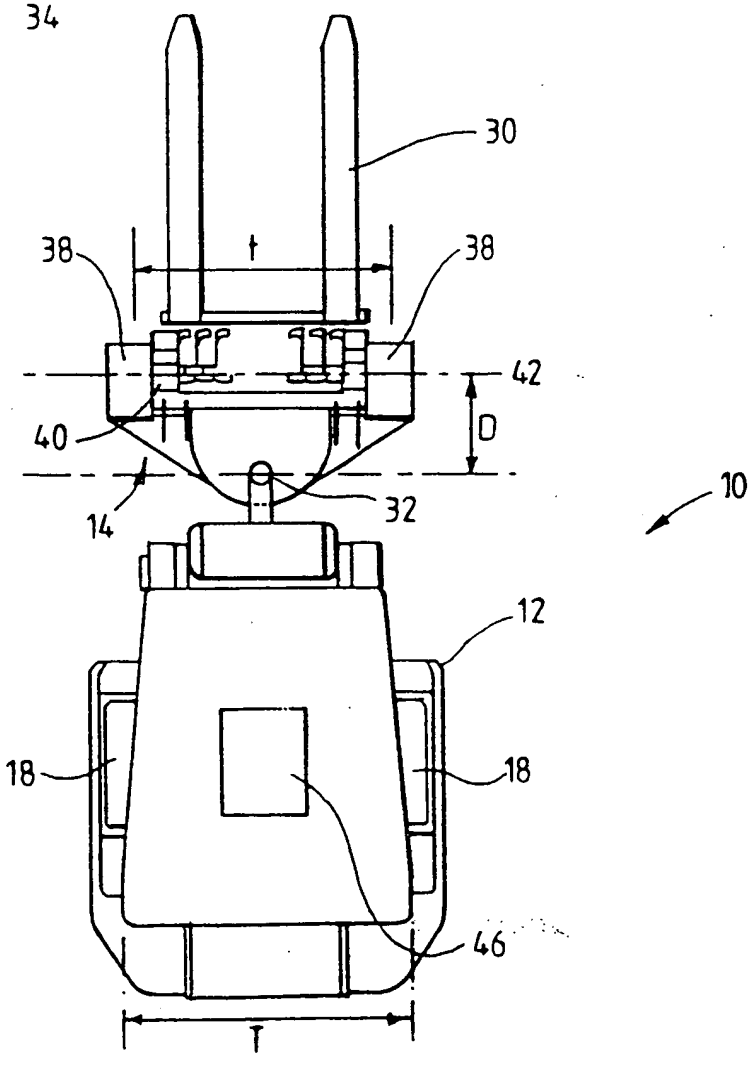
Fig.2.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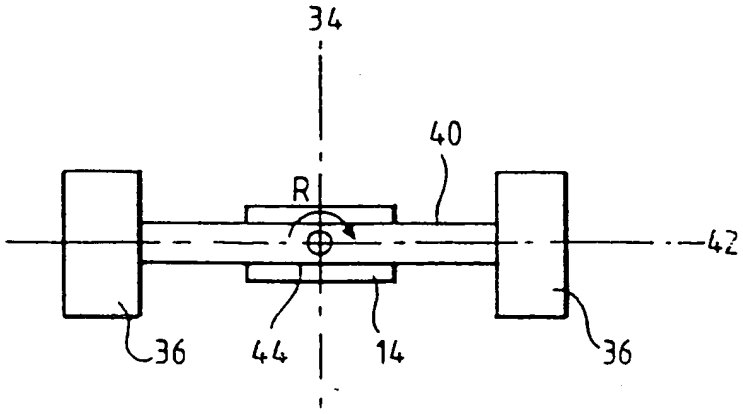

Fig. 3.

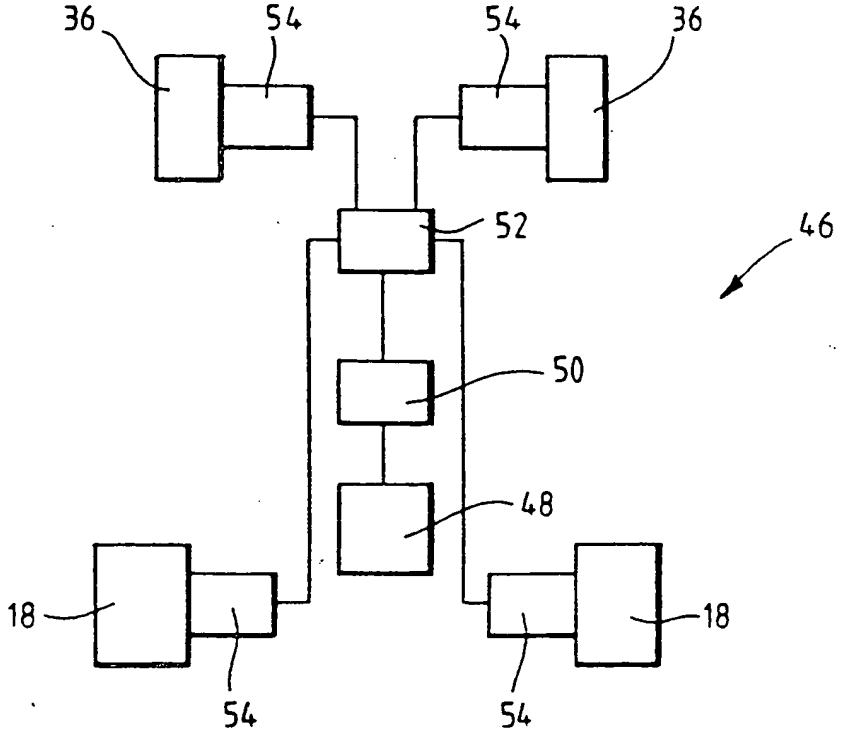

Fig. 4.

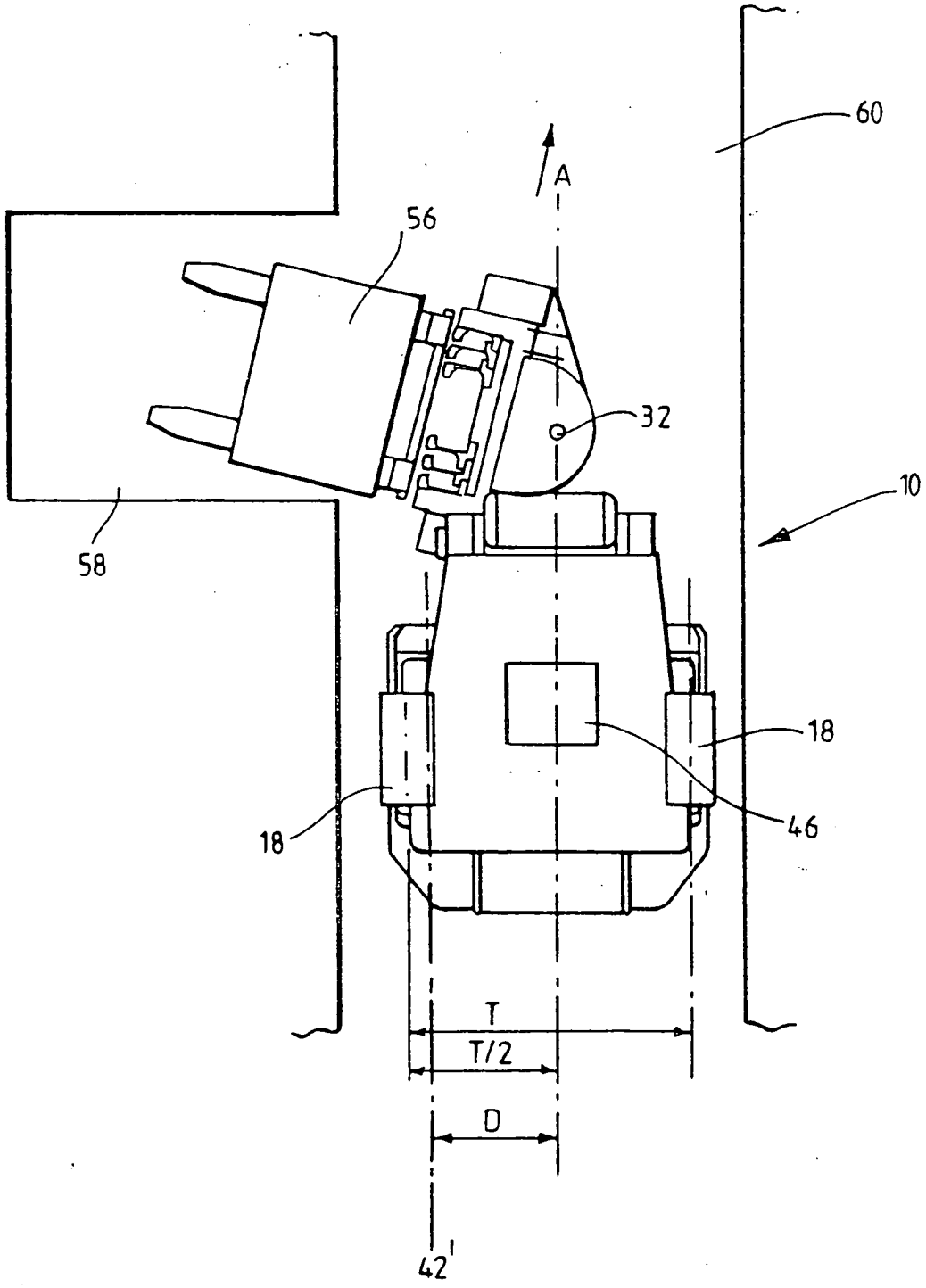

Fig.5.

LIFT TRUCK

The present invention relates to lift trucks, in particular fork lift trucks.

Lift trucks are known and fall into two broad categories, building trucks and warehouse type trucks.

Building trucks are used outside to transport material around building sites. Typically building trucks will have a mast with vertically moveable forks upon which the material can be lifted and carried.

Building sites have contrasting types of terrain, such as soft ground, rough ground and surfaces having loose material, in addition to the possibility of the terrain being wet and sloping. Therefore building trucks have particular features which enable them to negotiate such terrain.

To operate over rough terrain, the building truck must have a suitably high ground clearance in addition to the suspension properties of pneumatic tyres. The tyre footprint loading of the building truck must be sufficiently low to prevent it from sinking into soft ground. Consequently, high flotation tyres are employed, and the weight of the building truck is minimised, the weight being determined by the structural strength requirements of the truck.

To maintain traction over the various terrain, particularly when conditions are wet, and the surface is inclined, building trucks employ drive to all four wheels. This is particularly necessary when taking into consideration the low weight of the building truck. Furthermore the centre of gravity is located at the approximately the central position of the building truck to load all four wheels evenly, thus ensuring each wheel is capable of providing tractive force.

Building trucks must also be sufficiently manoeuvrable, and generally have the ability to turn the forks up to a maximum of about 45 degrees either side of the forward direction. However, angles significantly above 45 degrees are not used since they tend to make the building truck unstable.

Building trucks are powered by petrol or diesel driven internal combustion engines where the harmful emissions are diluted in the atmosphere.

Building trucks are not required to lift loads to very great heights because:-

a) other forms of lifting devices are available e.g. cranes.

b) lifting a load to a significant height, when the building truck is on uneven ground is dangerous since the truck may tip over as the load is raised. This is particularly significant on building trucks, which have pneumatic tyres (and hence allow roll or pitch of the truck body as the load is raised) and, as mentioned previously, building trucks are designed to be light (in line with strength requirements) and have a relatively high ground clearance (thus raising the centre of gravity of the truck).

Conversely warehouse type trucks are required to lift loads to significant heights and thus use a telescopic mast and fork arrangement to load and unload goods in loading bays, typically in the aisles of warehouses. To maximise space efficiency in the warehouse, the aisles are narrow, and goods are stacked vertically in the loading bay.

The conditions and the requirements of a lift truck in a warehouse, and the associated problems these conditions bring, contrast strongly with those conditions found on a building site and the requirements of a building truck.

Warehouses are inside and hence dry, the warehouse floor is generally hard and smooth, usually of concrete, as well as being flat. Therefore there are no associated traction problems associated with the warehouse type truck when moving along an aisle, and for this reason warehouse type trucks employ drive to the two rear wheels.

Operating inside a warehouse requires warehouse type trucks to be powered by power sources where there are no harmful emissions, such as gas fuelled internal combustion engines or electric motors. Therefore it would be inappropriate to use a lift truck powered by a petrol or diesel fuelled internal combustion engine in a warehouse.

To maintain the stability of the warehouse type truck, particularly when it is loading and unloading goods into the loading bays, extra weight is added to the rear of the warehouse type truck. The combined extra weight and the weight of the heavy goods exhibits high loading on the tyres of the warehouse type truck, and hence solid tyres are used, i.e. non-pneumatic tyres, which do not significantly deform during loading and unloading. Such tyres exert high loadings on the ground which must be sufficiently strong to resist such loads, hence the use of concrete.

The added extra weight results in the centre of gravity being located towards the rear of the truck. Thus, the stability of the truck is improved when steering at high steer angles.

The narrow nature of the warehouse aisles, requires the warehouse type truck to operate in a severely restricted space, hence the warehouse type truck must be able to load and unload goods into loading bays which are at 90 degrees to the aisle. This requires the front wheels and forks to be positioned at an angle of 90 degrees relative to the rear wheels.

A problem arises when power is applied to the rear wheels when the front wheels are angled at 90 degrees to the rear wheels, in that the front wheels tend to slip sideways relative to their normal direction of rotation, as opposed to steering the warehouse type truck into the loading bay as required. The truck tends to shuffle along the aisle resulting in the load becoming misaligned with its loading bay and the operator has to reverse and try again. This problem is more acute as the horizontal distance between the point about which the front wheels steer and the horizontal axis of the front wheels reduces. Thus it is difficult to manoeuvre the goods into the loading bay.

An object of the present invention is to provide a improved form of lift truck where this problem is reduced.

Thus, according to the present invention there is provided a lift truck including a pair of rear wheels mounted on a body, and a pair of front wheels rotatably mounted on opposing ends of an axle, such that the axes of rotation of the front wheels are fixed relative to each other, the axle being capable of rolling relative to the body and being pivotable through substantially 90 degrees either side of a straight ahead position relative to the body to steer the truck, in which all four wheels can be driven.

The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a side elevational view of a lift truck according to the present invention,

Figure 2 is a plan view of the lift truck of Figure 1,

Figure 3 is an exploded partial front view of the lift truck of Figure 1 showing various axes,

Figure 4 is a schematic view of the drive arrangement of the lift truck of Figure 1, and

Figure 5 is a plan view of the lift truck of Figure 1 when loading goods into a loading bay,

With reference to Figure 1 and Figure 2, there is shown a lift truck 10 comprising a body 12 and a lifting device 14.

The body 12 comprises a pair of rear wheels 16, the rear wheels 16 having solid tyres 18, a cabin 20 housing a seat 22, steering controls 24, pedals 26 and lifting controls (not shown).

The lifting device 14 comprises a mast 28, forks 30, and a mechanism (not shown) for raising and lowering the forks 30 on the mast 28. The mechanism consists of a conventional telescopic construction and can be driven hydraulically. The lifting device 14 is pivotally attached to the body at a pivot hinge 32 having a pivot axis 34.

The lift truck 10 further comprises front wheels 36, which are mounted below the lifting device 14. The front wheels have solid tyres 38, and are rotatably mounted on opposite ends of an axle 40. The front wheels 36 rotate about a common horizontal axis 42 to provide forward and reverse motion to the lift truck 10. Axis 42 is positioned at horizontal distance D forward of pivot axis 34.

Figure 3 shows that the axle 40 is pivotally fixed to the lifting device via a pin and hole arrangement 44 at the mid-point of the axle 40. Thus the axle 40 can roll relative to the lifting device 14, with the forward direction of the lift truck being taken as the reference axis for the rolling direction (R). This rolling of the axle compensates for small undulations in the flatness of the ground.

The pin and hole arrangement is arranged such that when the lifting device 14 pivots about the pivot axis 34, the axle 40, and hence the front wheels 36, also pivot about the pivot axis 34 to steer the truck.

Consideration of Figure 2 shows that the track T (which is defined as the transverse distance between the centre lines of two wheels on same axis) of the rear wheels, is greater than the track t of the front wheels. Furthermore, the horizontal distance D is less than half the track T of the rear wheels.

The lifting device 14 and hence the front wheels 36 are driven about the pivot axis 34 by a hydraulic steer arrangement (not shown).

Figure 4 shows a drive arrangement 46 which is provided for driving the front wheels 36 and the rear wheels 18. Means is provided for driving any wheel in a forward or reverse direction.

The power source for the drive system in this embodiment is an internal combustion engine 48 powered by a gas fuel. The internal combustion engine 48 provides power to a hydraulic pump 50. The hydraulic pump 50 feeds a control unit 52, which in this embodiment is a valve arrangement (not shown), the control unit 52 providing a variable output to four hydraulic motors 54, each hydraulic motor 54 driving an associated front wheel 36 or rear wheel 18. The control unit 52 is arranged such that it can regulate power to each of the four wheels.

In other embodiments, the power source could be a battery which in turn drives four electric motors.

Figure 5 shows the operation of the lift truck 10 when loading goods 56 into a loading bay 58, the lift truck 10 being positioned in a narrow aisle 60.

Consideration of Figure 5 shows the position 42' of the axis 42 relative to the body 12, when the front wheels are positioned at 90 degrees to the body 12. It can be seen that the horizontal distance D is less than ½ T, the track of the rear wheels.

To manoeuvre the goods 56 into the loading bay 58, the lifting device 14 is rotated about the pivot axis 34. It is necessary to manoeuvre the lift truck 10 such that front wheels 36 are substantially at 90 degrees to the lift truck body 12 in order to position the goods 56 in the loading bay 58 since the aisle 60 is relatively narrow when compared with the width of the body 12.

When loading the goods 56 it is necessary to drive the front wheels 36 into the loading bay 58. By regulating and controlling the power to the front and rear wheels via the control valve arrangement, a balance can be obtained that provides enough power to the front wheels 36 to enable the front wheels 36 to drive into the loading bay 58.

The ability to control the power to the front wheels 36 prevents the front wheels from being forced sideways in the direction of arrow A along the aisle, i.e. in the direction of the rear wheels when the front wheels are positioned substantially at 90 degrees relative to the rear wheels.

The ability to drive the rear wheels in opposite directions, whilst simultaneously driving the front wheels also considerably increases the manoeuvrability of the lift truck, enabling goods to be loaded and unloaded in confined spaces such as in the narrow aisle of a warehouse.

Claims

1. A lift truck including a pair of rear wheels mounted on a body, and a pair of front wheels rotatably mounted on opposing ends of an axle, such that the axes of rotation of the front wheels are fixed relative to each other, the axle being capable of rolling relative to the body and being pivotable through substantially 90 degrees either side of a straight ahead position relative to the body to steer the truck, in which all four wheels can be driven.

2. A lift truck according to Claim 1 in which the front wheels are driven by at least one front motor and the rear wheels are driven by at least one rear motor with both motors capable of being supplied with power from a power source.

3. A lift truck according to Claim 2 in which the front wheels are each driven by a respective motor.

4. A lift truck according to Claim 2 or Claim 3 in which the rear wheels are each driven by a respective motor.

5. A lift truck according to Claim 2 to 4 in which the power source drives a hydraulic pump.

6. A lift truck according to Claim 5 in which the hydraulic pump is a variable displacement pump.

7. A lift truck according to Claim 6 in which the variable displacement pump is a swash-plate type pump.

8. A lift truck according to 5 to 7 in which the motors are hydraulic motors.

9. A lift truck according to Claims 2 to 8 in which the power source is an internal combustion engine.

10. A lift truck according to Claim 9 in which the fuel for the internal combustion engine is a gas fuel.

11. A lift truck according to Claims 2 to 8 in which the power source is battery.

12. A lift truck according to Claim 11 in which the motors are electric motors.

13. A lift truck according to any preceding claim in which one rear wheel is driveable in a reverse direction whilst the other rear wheel is driven forwards.

14. A lift truck according to any preceding claim in which the track of the two front wheels is less than the track of the two rear wheels.

15. A lift truck according to any preceding claim in which the horizontal distance between the point about which the front wheels steer and the horizontal axis of the front wheels is equal to or less than half the track of the two rear wheels.

16. A lift truck, as herein before described with reference to, or as shown in Figures 1 to 5 of the drawings.